Understanding Screen-based Dining Practices through the Lens of Mindful Eating

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ABSTRACT

Our eating practices are increasingly overshadowed by the presence of screen-based media technologies that conflict with the ideologies of mindful eating. However, little is known about whether and how screens influence our eating behaviors. To contribute to this understanding, we present a rich account of dining practices of ten participants with and without screen. Our study revealed that eating with screens was found more enjoyable than eating alone. Screens can influence one's awareness of hunger and other behaviors like chewing rate and food gaze, whereas screen-media did not trigger any judgements for food. Drawing on the study insights, we highlight the role of technology to support bodily awareness, savoring, a non-judgmental attitude to eating and on rethinking distractions as companions. The outlined considerations encourage a creative yet careful take on making mindful eating more accessible within the realities of screen-based dining cultures.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

Screen-based dining, mindful eating, Human-Food Interaction

1 INTRODUCTION

Digital devices have a pervasive presence in our everyday life. We use them for a variety of tasks, eating is no exception. Televisions, tablets and phones all compete for our attention during mealtime, while social media platforms like Instagram and Facebook frame and intervene into much of our dining out experiences. Technology and dining are increasingly intertwined and from TV diners [83] to Mukbang [3] to Skeating (Skype + eating) [84], people are

now exploring new ways of digital commensality, i.e., eating together with technology. Screen-based dining, on one hand, could be a welcoming change especially for lone-person households who otherwise have limited means of social dining [66] but on the other hand, these screen-based eating practices, if sustained for longer periods, may impact one's physical and social well-being. For example, several studies suggest that eating while watching television [6, 28] and other forms of screen-based media [51, 70] is bad for our health, as it interrupts the physiological signals of satiety and hunger. As a result, people may forget how much they have already eaten, and may end up overeating. This mindless eating behavior over time may manifest into bigger problems such as obesity and heart diseases [28].

Consuming screen-based media during mealtime is problematic because it conflicts with the ideologies of mindful eating. Mindful eating is a holistic practice of eating with the intention of caring for oneself by noticing and enjoying the food, recognizing its effect on the body, and knowing when to stop [58]. Mindful eating creates a new awareness around food choices and their consumption, as individuals begin to acknowledge the influence of the environment and the types of food they choose to consume (ibid). Although mindful eating is not directly concerned with restricting calorie intake [20], numerous studies indicate the benefits of mindful eating towards regulating healthy eating behaviors [88, 102]. Seeing these benefits, countries like Canada [36] have recently updated their general nutritional guidelines to include mindful eating. This non-diet approach to eating however, emphasizes on savoring the moment and encourages diners' full presence to the eating experience without any distraction [26] and thus conflicts with the prevalent screen-based dining culture, where screen content may take away the diner's attention from food.

In principle, distractions of all kinds including screens should be avoided if one wants to eat mindfully. But this is easier said than done. For example, a study conducted by *OnePoll* [85] on eating habits and behaviors with 2,000 Americans found that 91% reported watching TV while eating a meal or snack and 49% reported that they do so regularly. Given the mass appeal of immersive media, it is doubtful that individuals will stop using screen-based media while eating [73, 85]. Existing research also highlights the struggle in identifying and coming to a general agreement on the appropriate use of screen time during meals [38, 59]. Besides, changing dynamics with work-from-home and stay-at-home necessities, as observed in the current COVID-19 pandemic, can make it even harder to not use digital devices and screens during mealtime [56], especially for someone who is living alone and has no other means of communal dining. In such cases, banning the use of screens during mealtime in its entirety might not be an ideal way forward. Rather, a conceptual

breakthrough is needed, where we acknowledge the pervasive presence of screen-based media in our lives and use it as a facilitator for supporting healthy and mindful eating practices. Such technical innovations, however, require more nuanced understanding of the relationship between the eating practices and screen consumption, which this research aims to offer.

This paper aims to understand whether and how screens influence our eating behaviors, i.e., 'how' we eat and how screen-based dining behavior differs from dining alone. To contribute to this understanding, we conducted a mixed method field study with 10 participants where we documented their eating practice with and without screen, using video recordings, semi-structured interviews, and diary logs. Each participant video-recorded two meal sessions for each context (four meal sessions per participant) and these sessions helped us to bring a contrast in their eating patterns for with and without screen contexts. Ferriday et al. [25] define eating topography as the pattern of behaviors associated with eating such as swallow rate, bite-size, eating rate (no. of chews per mouthful), and inter-bite interval. We build upon this definition to understand the eating patterns. We found that screens can influence one's awareness of hunger and eating behaviors like chewing rate, attention to the food and meal duration differ in each context. Interestingly, participants' appreciation for food was mainly driven by its taste and screen has little effect on their judgment of food; rather they used the screen media to make the bland food palatable. Finally, eating without screens was found less enjoyable. Screens offered a sense of companionship that led to more enjoyable meals, and participants described choosing the screen content carefully for mealtime.

This paper contributes the first conceptual understanding of screen-based dining behaviors from the lens of mindful eating. While prior works in HCI focus on understanding and enhancing social interactions through technology during family mealtimes [3, 19, 22, 41, 71], we investigate the effects of screen technologies on the eating behaviors of solo diners with and without screen. We conclude the paper by describing four design considerations to guide the future development of technologies for supporting mindful eating within the realities of screen-based dining cultures. The outlined implications encourage a creative yet careful take on how to make mindful eating more accessible within the everyday eating practice, dominated by screen use.

2 BACKGROUND AND RELATED WORK

Below we discuss the existing literature on technologies for mealtimes and mindful eating.

2.1 Technologies for Mealtime

Eating practices is a topic of interest in the HCI community. From dietary monitoring systems [91, 96] to novel interactive eating experiences [5, 43, 48, 67, 98] to digital commensality [3, 8, 66, 84], to qualitative studies of eating practices [15, 19, 22, 38, 41, 71], there is a growing interest in understanding and designing for eating practices (see [46] for an overview). Besides, from interactive furniture [62] to tableware [65], to telematic dinner parties [8] to robotic dining companions [60] to 3D printed food [32], several

works also put forward exciting possibilities of digital commensality at the convergence of dining and technology. For example, works by Ferdous and team [22, 24] and O'Hara and colleagues [69] suggest how interactive technologies can act as a medium to facilitate shared activities that can lead to a positive experience of eating together in a home setting. Davis and team [19] illustrate that even in semi-public spaces, the use of digital technologies can serve to entertain, support, and bridge intergenerational interaction at the table. These HCI works challenge the common view on using screens at mealtime by showing the positive side of digital technologies in facilitating novel dining experiences and rich social interactions.

The existing works have explored the use of technology for mealtimes with family members [22, 24], friends coming over home [69] and family members eating out in restaurants [19]. However, there is a limited understanding on how the screen is used by solo diners while eating. Moreover, the existing works do not dive into the topic of mindful eating and its relation to screen-based dining practice. Little is known on whether and how eating practices are influenced by the presence of screen-based media. For instance, what are the commonly observed eating patterns during screen-based dining and how do they differ from eating in the absence of screens? How much attention do people pay to their food when their mind and eyes are focused on the screen? Do people recognize and respond to their hunger and satiety cues during screen-based dining? How does the screen affect the pace and duration of the meal?

Questions like these are important to investigate because food decisions happen in the moment [74], and yet many people are unaware of their subconscious choices and behaviors related to their eating, especially when they are distracted by other factors such as screen-based media. Such mindless eating behavior if sustained for longer could have implications to one's physical, mental as well as social health [68, 100]. As such, understanding 'how one eats' can be as valuable as knowing 'what one eats' to support one's health and wellbeing. This aspect of 'how one should eat' can be understood through the concept of mindful eating, which we cover next.

2.2 Mindful Eating

Mindfulness is a state of consciousness that can be fostered by training the mind to pay attention to one's present-moment experiences in a non-judgmental manner [80]. Like eating practices, the concept of mindfulness has also found its ground in the HCI literature with systems [18, 54] and review articles [90] discussing interesting technological designs to support various aspects of mindfulness, such as using Brain-Computer Interface (BCI) based mandala coloring for focused attention [18] and using drones to support Tai-Chi like slow movement [54]. Going through all prior works on mindfulness is beyond the scope of this paper. Rather we focus our attention on mindful eating, which in comparison, has gathered less attention in HCI.

Mindful eating in simplest terms may appear as application of mindfulness techniques to eating, but a closer look at the prior literature reveals the multifaceted nature of mindful eating that is difficult to encapsulate in one clear definition [57]. Rather, existing

Table 1: Five principles of mindful eating used in this study and their occurrence in prior literature

Principle	Description
Awareness of bodily cues	Being aware of the bodily triggers for initiating (hunger cues) and stopping eating (satiety cues) [1, 27, 30, 58, 63, 88, 110]
Savoring	Enjoying food using all the senses, i.e., by noticing the presentation, sound, taste, texture, and smell of foods [1, 10, 12, 27, 30, 58, 63, 88, 110]
Slow eating	Chewing each bite properly to promote awareness of food sensory properties and bodily sensations [1, 26, 58, 63, 107, 110]
Avoiding distractions	Devoting full attention to food by avoiding all distractions [10, 58, 63, 88, 110]
Being non-judgmental	Acknowledging responses to food without any judgment [12, 27, 30, 63, 88]

works describe mindful eating in terms of a collection of different principles. We review the important works to formulate the key principles of mindful eating. We have employed these principles to analyze our study data.

According to Fung and colleagues, mindful eating is the non-judgmental awareness of internal and external cues influencing the desire to eat, food choice, the quantity of consumption, and the way food is consumed [30]. *The Center for Mindful Eating* [108] describes mindful eating in the form of *BASICS* where '*B*' stands for '*Belly check Before Eat*'; '*A*' stands for '*Assess and check Your Food*'; '*S*' stands for '*Slowdown*'; '*I*' stands for '*Investigate Hunger Throughout Meal*'; '*C*' stands for '*Chew Food Thoroughly*' and '*S*' stands for '*Savor Your Food*'. According to Albers [1], mindful eating is a three-step practice: The first step is paying attention to thoughts surrounding all five senses, including the textures of the food. The second step is identifying and minimizing multitasking or having an unconscious awareness of eating. The final step is noticing the triggers that initiate and cease eating. These key steps involve disconnecting from previous automatic behavior patterns, and learning new, more relaxed and engaging ways of eating.

Beshara and colleagues [12] define mindful eating as a "*non-judgmental awareness of physical and emotional sensations while eating or in a food related environment*" (p. 26), thus acknowledging the importance of also being attentive to environments that may trigger a range of physical and psychological reactions. For Tapper [89], mindful eating involves paying attention to the sensory properties of food as one eats, paying attention to internal and external cues that elicit eating or the desire to eat and taking a non-judgmental attitude to any of these thoughts, feelings or bodily sensations. Besides these scholarly articles, we also investigated mindful eating coaching sessions [108], online training websites [52, 107], nutritionist and dietitians fact sheets [10, 109] and general interest books [26] to gather an understanding of what constitutes a mindful eating behavior in practice [82] and to arrive at a set of five principles for mindful eating (refer Table 1).

2.3 Technologies for Mindful Eating

We describe the existing technologies for mindful eating around two categories: educational and reflection-based methods. The educational approach aims at educating people on the importance of mindful eating to help them in practicing such behavior. In-person training programs such as MB-EAT [53] are a good example of this approach. The MB-EAT program incorporates a wide range of

mindfulness-based activities that teach participants awareness of external and internal eating cues and meditation techniques. Such training sessions have shown significant psychological benefits for treating eating disorders and obesity [17] However, such programs require dedication and commitment in terms of time to reap their full benefits. Additionally, little is known on how participants could utilize the learned strategies from the training sessions in their everyday eating practice.

Reflection-based approach, on the other hand, encourages individuals to maintain a food journal and reflect on their eating behavior using paper-based diaries [93], prescribed daily home exercises [2], and smartphone-based food journaling apps [21]. For example, Robinson and colleagues [76] developed an app in which users take pictures of their food and review these pictures when deciding what to eat next. The app does not ask or try to infer nutritional information, but instead it encourages users to reflect on how they felt after eating the food. Epstein and team [21] developed a mobile app called Crumbs, which features a daily lightweight food-based challenge that users complete by taking a picture of and consuming one food or meal matching with the challenge. The accompanying study of the app illustrated that non-nutritional challenges like '*Eat something that reminds you of your childhood*' increased mindfulness than nutritional challenges like '*Eat something high in fiber*'. FoodScrap [55] is another food journaling app that allows people to capture food components, preparation methods, and food decisions using speech input. Besides manual journaling methods, the use of wearable cameras [92], acoustic sensors [105], EMG-measuring eyeglasses [39] and in-ear microphones [31] have also been explored to automatically detect and monitor eating activity. These automated methods however struggle to offer consistent results in real-world environments [91]. Finally, there are also playful systems like *SWAN* [48], *iScream* [99] and *Guardian of Snacks* [44] that aim to support mindful eating through multimodal feedback and playful nudging.

These works however, do not investigate all aspects of mindful eating and so far, there is a limited understanding on how mindful eating unfolds in real-world scenario. Most of the research on mindful eating practices are primarily focused on managing eating disorders and are primarily conducted in laboratories under controlled conditions (for example, see [25, 75]). Researchers have therefore emphasized the need to conduct further research on mindful eating practices in-situ [30, 89] – which this research aims to address.

Figure 1: A snapshot from the recorded meal session for screen context. The participant was watching 'The Imitation Game' movie on her laptop. The two mobile phones placed on the table were not used during the mealtime. Participants recorded their meals with one camera. The image is partially blurred to prevent de-anonymization.

3 FIELD STUDY

We conducted a field study to understand the influence of screens on the eating behaviors of solo diners. We investigated two eating contexts: eating with screen and eating alone without any screen. The study was approved by the university ethics board. Ten participants of different nationalities participated in the study: 6 were from India, 2 from Columbia, 1 from Philippines, and 1 from China. Participants were recruited through advertisements on university boards, mailing lists, and social media platforms. Participation was open to any healthy person aged 18 and older, who commonly have their meal in front of the screen. Participants were in the age range of 20-40 years at the time of the study, which is a typical age group amongst whom dining in front of the screen is quite popular [73]. Out of the ten participants, six were bachelor and four were married (both the couples participated in the study). Seven participants were students and three were professionals. During the study period, all participants were living by themselves without any other flat-mates, kids or pets. Although the couples participated in the study, they ate alone in all the four sessions. Each participant received a $20 gift card as an appreciation for their contributions to the study. Table 2 provides more details on the study participants and the meals consumed in different sessions.

The study took place in the participant's home for three weeks. We provided participants with an action camera and a diary to document their eating activity. In the first meeting, participants were given a demonstration on how to operate and place the camera such that it is placed at a position that is not directly intrusive yet has a good view of their upper torso and meal to support data collection. Each participant video recorded two sessions each for eating alone and eating with screen-based media (in total 4 meals). The ordering of the meals was counter balanced. Participants decided the time (either lunch or dinner), meal content as well as the audio-visual media content for all the meals. Figure 1 shows a snapshot from the recorded meal of one of the participants when she was eating

in front of a screen (laptop). The study happened during the period March – August 2019.

3.1 Scope

Before describing the study findings, below we mention the scope of this work.

- This is primarily a qualitative study and not a comparative quantitative study of two eating contexts. We are not aiming to advocate one over the other nor are we interested in achieving a collective consensus across a wider demographic. Hence, we have not employed any statistical methods in our study. However, we have used numerical data to highlight the subtle differences in participants' eating topography, where the quantitative data is mainly used to support the insights gathered through the interviews and diary logs. Our aim behind this qualitative work is to paint a richer and realistic picture of eating practices for interpretive explanation and not for prediction; as well as to invite discussions and further research on this topic.

- Our aim with this research was to understand how technologies can be designed for individuals who primarily eat in front of the screens; hence we recruited those individuals who commonly eat in front of the screens. Participants were not required to have any prior experience with mindful eating. Mindful eating is only used as a theoretical lens to understand whether and how screens can influence the eating behaviors during screen-based dining.

- There exist quantitative measures to investigate participants' eating practices such as the *Mindful Eating Scale (MES)* [40], the *Mindful Eating Behavior Scale (MEBS)* [104], and *Mindful Eating Questionnaire (MEQ)* [27]. These tools generally focus on one specific eating style but do not cover all aspects of mindful eating. For example, *MEQ* has been criticized for not including the nonjudgmental construct of mindful eating

Table 2: Details of participants and their meal sessions (*All names are pseudonyms). Rice, noodles and ravioli were eaten with cutleries whereas the remaining items were eaten with hands.

#	Participant details	Sessions recorded (not in the same order)	Meals consumed
1	Yulia (F,22)	Meal 1: Without screen	Rice & veg curry (lunch)
		Meal 2: Without screen	Rice & meat curry (lunch)
		Meal 3: With screen (Laptop)	Rice & veg curry (lunch)
		Meal 4: With screen (Laptop)	Rice & veg curry (lunch)
2	Belinda (F,22)	Meal 1: Without screen	Rice & fruits (breakfast)
		Meal 2: Without screen	Sandwich & fruits (breakfast)
		Meal 3: With screen (Laptop)	Noodles (dinner)
		Meal 4: With screen (Laptop)	Sandwich & fruits (breakfast)
3	Tripti (F,22)	Meal 1: Without screen	Rice & veg curry (lunch)
		Meal 2: Without screen	Chicken rice (dinner)
		Meal 3: With screen (Laptop)	Rice & fritters (dinner)
		Meal 4: With screen (Smartphone)	Rice & egg curry (dinner)
4	Prachi (F,24)	Meal 1: Without screen	Chicken rice (lunch)
		Meal 2: Without screen	Rice & meat curry (lunch)
		Meal 3: With screen (Smartphone)	Wrap and coffee (dinner)
		Meal 4: With screen (Smartphone)	Fritters and dessert (dinner)
5	Henry (M,24)	Meal 1: Without screen	Ravioli (dinner)
		Meal 2: Without screen	Quesadilla (dinner)
		Meal 3: With screen (TV)	Rice & curry (dinner)
		Meal 4: With screen (Smartphone)	Wrap (dinner)
6	Violet (F,26)	Meal 1: Without screen	Ravioli (lunch)
		Meal 2: Without screen	Mexican Salad (lunch)
		Meal 3: With screen (TV)	Ravioli (lunch)
		Meal 4: With screen (Laptop)	Salad (lunch)
7	Nina (F,30)	Meal 1: Without screen	Fruits & smoothie (breakfast)
		Meal 2: Without screen	Fruit plate (breakfast)
		Meal 3: With screen (Laptop)	Fruit plate & tea (breakfast)
		Meal 4: With screen (Laptop)	Noodles & soup (dinner)
8	Rahul (M,29)	Meal 1: Without screen	Cereal & eggs (breakfast)
		Meal 2: Without screen	–discarded–
		Meal 3: With screen (TV)	Rice, fritters & soup (dinner)
		Meal 4: With screen (Laptop)	Rice & veg curry (lunch)
9	James (M,31)	Meal 1: Without screen	Noodles & bread (lunch)
		Meal 2: Without screen	Chicken sandwich (lunch)
		Meal 3: With screen (Laptop & computer)	Samosa, slice of pizza (lunch)
		Meal 4: With screen (Smartphone)	Bread & Chicken (lunch)
10	Timothy (M,31)	Meal 1: Without screen	Soupy noodles (dinner)
		Meal 2: Without screen	Soupy noodles (dinner)
		Meal 3: With screen (TV)	Soupy noodles (dinner)
		Meal 4: With screen (TV)	Soupy noodles (lunch)

[40]. As our aim was to gather rich qualitative data, we did not these scales in our study.

- We let participants choose their meal to keep the mealtimes natural, which was required for the ecological validity of this field study. Besides, restricting the meal choice in the study would have negated the very purpose of this study, as mindful eating does not promote dietary restrictions [30]. Finally, there were ethical and pragmatic concerns over choosing one specific food that all 10 participants from four different cultures would have happily consumed four times.

- Eating practices, in general, is a complex topic [101] and a variety of social, cultural, economic and contextual factors play a crucial role in shaping what and how one eats. We acknowledge that this study looks at some specific aspects of one's eating behavior and one study might not be enough to cover all the external factors that can affect one's eating. Further studies are needed to gather a holistic understanding on eating practices.

- This research does not focus on a specific screen-based technology but rather media devices in general, which include

Table 3: The diary log consisted of 7 questions, which participants were asked to answer after every meal recording.

Question	Description
Q1	When and where did you eat? Describe the dining context.
Q2	What made you decide to eat? Describe your hunger level on the hunger-satiety scale
Q3	What did you eat? Describe it using all your senses (sight, smell, hearing, taste, and touch)
Q4	What else was happening while you were eating?
Q5	How did you decide to stop eating? Describe your satiety level at the end of the meal on the hunger-satiety scale
Q6	What thoughts and emotions came to your mind when you finished eating?
Q7	Anything else that you want to add or reflect upon

Figure 2: Hunger and Satiety scale used in the questionnaire, adapted from [53].

the commonly used devices like laptops, television and mobile phones. Besides, there are so specific focus on one kind of screen-content. Participants were free to view anything of their choices be it movies, tv-series, news or even browsing. It is beyond the scope of our study to discuss the impact of individual technology on people's eating behaviors.

3.2 Data Collection

The data was collected through three sources: video recordings of the meal, interviews, and diary logs. In total, we collected 40 video recordings, 10 interview recordings and 40 diary entries from the participants. We next describe our research methods.

Video recordings: Video recording is an established data collection method [61] to capture and understand nuanced practices of participants as seen in earlier field studies [22, 24]. Although there are concerns related to the use of video recording that having a camera may influence the natural behavior of participants. Existing research, however, suggests that people habituate to the camera quite rapidly and the effects of the camera wear off with use [42]. Nonetheless, we took further measures to minimize any potential concerns. Firstly, we used the DJI Osmo Action 4K Camera for recording meals, which is a relatively small action camera (65×42×35 mm). Secondly, to keep the setting naturalistic, we only installed one camera to capture the eating patterns. The media content was understandable through the audio captured by the installed camera and participants also noted the content in the diary. Moreover, we also gave participants GoPro mini tripods for easy placement of the camera and making it easier to blend the setup in the surroundings. Finally, we asked participants to record two sessions per context to minimize the potential effects of video recording on people's behavior, if any.

Interviews: We also conducted a semi-structured interview with every participant on the day of debriefing and enrollment in the

study. The interview lasted for about 30-40 minutes. The focus of this interview was to understand participants' existing eating practices and their relationship with screen-based media during dining. All the interviews were audio-recorded for later analysis.

Diaries: We provided participants with diaries and asked them to reflect on their eating practice after every recorded meal. Table 3 lists the questions that were asked in the diary. These questions were adopted from the mindful eating workbook [93]. Figure 2 features the hunger satiety scale [53], which was used in the questionnaire to understand participants' hunger and satiety levels before and after the meal.

3.3 Data analysis

Employing thematic analysis [13], we followed both inductive and deductive approaches to analyze the collected data. While our analysis was primarily deductive and was guided by the five principles of mindful eating (refer Table 1), we also followed an inductive approach to let new themes emerge from the collected data. In the first round of coding, we used five themes named after the principles of mindful eating to describe our findings. However, later we renamed the third theme on '*Slow eating*' to '*Eating topography*', as eating behaviors are multifaceted and speed only cannot describe the eating practice [25]. Additionally, we created sub-themes under these main themes for better description. In the initial rounds, there were 28 sub-themes which were further refined to create the final set of 21 sub-themes.

We used videos to understand the eating topography of participants that is hard to obtain from questionnaires or interviews. In total, we studied the following four aspects of eating topography: (1) no. of chews per mouthful, (2) inter-bite interval, (3) meal duration, and (4) food gaze (refer Table 4). We defined food gaze as a little longer attention to food (5 seconds or more), other than picking up the food. This duration was decided based on the initial

Table 4: Details of the eating topography.

#	Aspects of eating topography	Description of the aspects of eating topography
1	Number of chews per mouthful	The number of times a bite was chewed
2	Inter-bite interval (in seconds)	Gap between two bites. A bite refers to the amount of food taken in the mouth at a time for eating
3	Meal duration (in minutes)	Amount of time take to finish the meal
4	Food gaze (in seconds)	Time spent on gazing the food other than picking it up from the plate

analysis of meal sessions of two participants. We did not consider other factors like swallow rate and bite size, as they were difficult to identify from video recordings.

Data from the four meal sessions of each participant were populated in an excel datasheet under their pseudo-name (10 sheets in total). This helped us to collate all meals of each participant in a single excel sheet. The video files were played in a media player and the timestamp for every action was recorded in the corresponding excel sheet. We discarded one session of Rahul for solo dining as he accidentally started browsing his phone during his meal. For consistency in the video analysis, two authors analyzed two video recordings of different participants together and populated the excel sheet around the eating topography listed above. Later, the last author analyzed all the video recordings and discussed the emerging findings with other authors.

Manual analysis of 40 video recordings (over 12 hours of footage) was a time consuming and tedious task, but it was necessary to identify subtle differences in eating topography. To the best of knowledge, there does not exist a software that can automate this process. Since our focus was on understanding individual experiences, we plotted separate bar graphs for each participant to illustrate the differences in eating topography between the two study contexts (eating alone vs eating with screen-based media).

After analyzing the video recordings, we transcribed and analyzed the interview recordings to find participants' quotes that could elaborate on the five principles of mindful eating and eating behaviors. Similarly, we analyzed the diary entries to support the data obtained from the video recordings. The diary entries were also added in the same excel sheets of participants as developed for video analysis. Next, we describe the study findings across five main themes.

4 FINDINGS

We now describe the insights related to both study contexts: eating with and without screen-based media.

4.1 Being Aware of Bodily Cues

This theme describes how participants respond to bodily cues of hunger and satiety in both the contexts.

F1: Screen dining did not influence the body awareness. We found that the screen did not influence the body awareness of participants. Participants were aware of what was happening in the background, and how the food can impact their body later (refer Figure 3). The analysis of the diary entries also showed that screen-based media
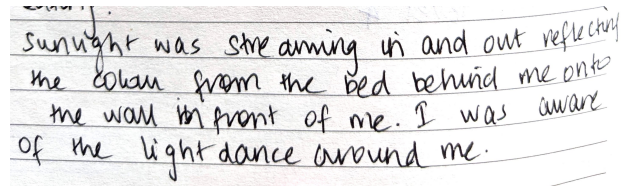

Figure 3: Nina described being aware of the sun dance during screen dining.

had no influence on participants' hunger and satiety levels. Participants gave similar ratings for hunger and satiety in both the study contexts (refer Figure 2 for the hunger-satiety scale). For the without screen condition the average value of hunger was 3.70 (meaning very hungry) and 6.45 for satiety (slightly uncomfortable). For the screen condition, the average value of hunger was 3.75 (meaning very hungry) and 6.1 for satiety (pleasantly full). According to the hunger satiety scale [94], a value of 3 for hunger and 6 for fullness describe comfortable eating. Similar ratings in both contexts indicate that the screen did not influence participants' decision to start and end the meal.

F2: Attending to signals of stomach growling and burping was important. The interview data provided further details on how participants relate to their bodily cues. Some participants mentioned that they do consider bodily cues such as stomach growling or burping for deciding when to eat and when to stop. Rahul described his hunger cues in this way, "*There's this little tingling sensation that happens in my stomach, that's how I know that I'm hungry and decide to eat.*" Prachi mentioned that hunger reduces her concentration and then she decides to eat, "*When I'm hungry for long, I'm irritated, I can't think straight, I feel dizzy. And when I'm full I know I can't eat anymore; I have the urge to stop eating and I tend to burp which is when I stop eating.*" While we did not observe any direct bodily cues related to hunger or satiety like stomach growling or burping in the video recordings of the meals; but in the diary logs, participants mentioned having headaches and stomach growling as drivers for having meals.

F3: Screen based work led to dismissal of hunger cues. Participants mentioned that when they are engaged in screen-based work, they sometimes dismiss their hunger cues and continue working. Violet mentioned that screens make her out-of-sync with her hunger cues: "*If I am working here [on a computer], I do not always realize that I am hungry. I get irritated and then I behave [referring to how she eats] like a monster.*" She further described how not attending her hunger cues on time create issues for her: "*When I get very, very*

hungry, I feel like I need to order everything. I need to have it; I need to see it on my plate. Otherwise, I am going to die. I would regret it later as I would not finish all of it." Tripti also had similar thoughts, "*When I am busy, I skip meals very often which causes a headache, which then prompts me to eat something junk*".

F4: Habits as well as body clock defined the meal timing. Five participants also described that they do not always eat depending upon their hunger or satiety level. Instead, time and the body clock play important roles in deciding when to eat and how much to eat. Henry mentioned, "*Around 12pm, my stomach fires signal to my brain that I need to eat.*" Rahul reflected upon his practice on how he knows when to stop, "*[...] when I'm 15 minutes into my meal, that's around the time I know that I'm comfortably full, but I still have some room for food. So that's my indication to stop because it has reached about 80-90% of my satiety level.*" Timothy mentioned dismissing his hunger cues altogether in late evenings: "*There are times when I return from the University after 10 pm, then I might just not eat, because I would have to give enough time for the food to digest before I sleep.*" Nina on the other hand, described eating a bit more to avoid late night snacking: "*[...] since we [refers to her partner] consume an early dinner and considering we're up till late, there's a huge possibility that we would feel hungry again late at night and I would not like to succumb to the urge of snacking because of which I would like to eat a little extra during dinner.*"

F5: Availability of food prompted more eating. Some participants described their struggle in understanding the bodily cues in general. Henry described that his eating depends upon the availability of food, "*I think with me there's no fullness signal, I can eat as much as you put on the plate for me. If I have access to a lot of food, I'll eat a lot of food, but if I have access to less food, I will eat less.*" James also mentioned a similar issue, "*I'll be honest, there are certain times when I still don't know [if I am full]. But I guess one way to know that I'm still hungry is if I am snacking afterwards. [. . .] But I do not think [my eating behavior] varies with screen engagement.*"

4.2 Savoring Food

The second theme describes attention given to the sensory aspects of the food in both contexts that were driven primarily by the taste of the food, if it had any connection to the self (emotionally or through participating in cooking) and whether it was eaten with others.

F6: Screen provided distraction to savor bland food and suppress cravings. None of the participants mentioned screens affecting their appreciation for food. Figure 4a shows Belinda's comment on how she was enjoying both the food and media content. Screens were mainly used as a distraction to consume less tasty food. Belinda described, "*If the food doesn't taste good, then I either don't eat it or I distract myself and eat with some [screen] entertainment. But if the food I'm eating is tasty, then I might not bother much about what's on screen, my focus will be more on the food.*" She also made a note in her diary about not missing the phone as the food was tasty (Figure 4b). Prachi mentioned to satisfy her cravings using screen-media, "*Sometimes, I will suppress my cravings and distract myself by watching something on screen.*"
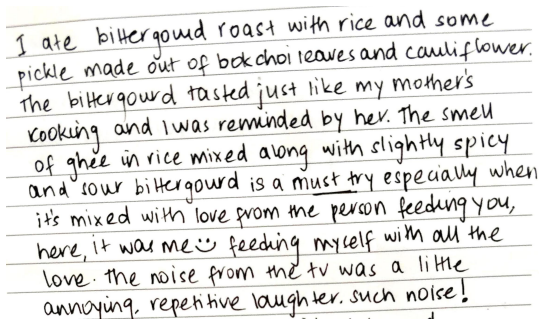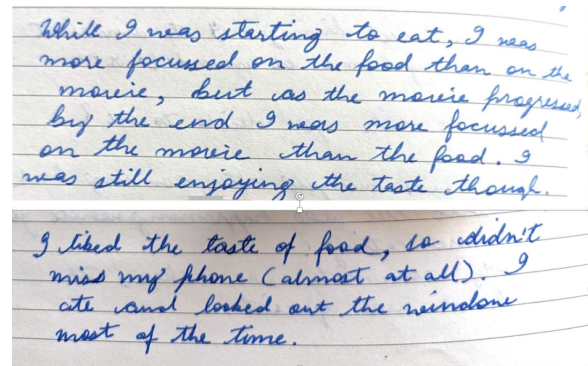

Figure 4: a) Belinda mentioned how she savored food in screen dining b) In solo dining, Belinda mentioned not missing her phone as the food was tasty

Figure 5: Participants provided detailed description of the meals they consumed for both contexts. A snapshot of Rahul's diary entry for the screen-based dining session.

F7: Tasty meals were savored more. We asked participants to describe their meal with all the senses in the diary (Q3), to which we received very detailed responses. Most participants were quite eloquent in noting sensory features of the meal that they consumed. Figure 5 shows the diary log of Rahul for screen dining. Taste of the food was described as the major factor to enjoy food, and all participants tried to enhance the taste of their meal when they weren't satisfied.

F8: Self-cooked meals felt more rewarding. Six participants mentioned that they savor the food more if they are involved in the making of it. Cooking was described as a key activity that leads to a pleasurable experience. Timothy described, "*For me it's mostly the process of preparing food that matters as an experience than the actual act of eating. Bringing all the raw ingredients together and creating a meal gives me more satisfaction than eating the meal itself, even if they do not turn out to be as precise as he had expected.*" Similarly, James also mentioned the criteria for having a satisfactory meal is

Figure 6: Snapshot of the diary entry by Nina: She described enjoying the self-cooked food while dining with screen.

cooking. He said, "*Cooking probably will most likely increase that satisfaction. Because it gives me an idea that yes, I can create a very tasty meal.*" Nina also expressed her joy of eating the self-cooked food in the diary while dining with screen (refer Figure 6). The video recording also supported her diary log, as she ate her meal with a constant smile on her face.

F9: Emotional attachment was found critical in savoring the food. Besides cooking, participants savored food more if they had some sort of emotional attachment with it. Henry described, "*I think I enjoy it most when I tie some sort of emotion to it. So, if she's [his partner, Nina] cooking then it's special to me. Or, if we're having something from my home country.*" Nina mentioned the importance of nostalgia, "*If it [food] tastes just like my mom's cooking, then I would like to eat a little more just to keep the taste lingering in my mouth while I relive those memories momentarily.*"

F10: Social eating enhances the food savoring. Social aspects of the mealtime were also described as important in savoring the food. As Rahul noted, "*Social setting definitely improves the taste. Friends make eating more enjoyable.*" Henry also expressed similar thoughts, "*For me, more than the food it's the social part of it. I love having a meal together. We [referring to his partner, Violet] have such different worlds that we share a lot over meals.*" Timothy on the other hand, described the joy also comes from putting in more effort while cooking for others, "*I would put more effort into the meal if I was cooking for friends or family. It feels rewarding. But if I'm cooking just for myself, I will probably keep it simple.*"

4.3 Eating Topography

The third theme looks at the eating topography of every participant.

F11: Screens affected the eating topography. From the video analysis of the meal sessions, we found that the screen influenced the eating topography of the participants as seen in Table 5. Since there are no defined values for eating topographies that one should follow for practicing mindful eating, we can only highlight the differences in the eating behaviors for both contexts without commenting on which one is bad and which is good.

On the other hand, video analysis revealed that five participants: Prachi, Violet, Yulia, Belinda and Tripti, chewed their food more in the presence of the screen media than in solo dining condition as seen in Table 5. They also showed increased inter-bite interval,

which means that there were longer pauses between every two bites during screen-based dining. Hence, their meal duration was also longer in screen-based dining than solo dining, except for Belinda who consumed less portion of food in screen dining than the solo dining. This suggests that these participants tried to finish their food more quickly during solo dining, whereas they were a bit relaxed while eating with screen-based dining. As Yulia quoted, "*If I'm eating without any entertainment, I might eat faster because I need to get it done with. I'm not very fond of eating.*" There were no instances of food lingering in the mouth or hand, which suggests that participants were aware of their food and were not immensely immersed in the media content. In terms of food gazing, Prachi did not gaze at the food during screen-based dining as her complete attention was on the screen content. On the other hand, Violet, Yulia and Belinda gazed at the food less in screen-based dining than solo dining.

Rahul, Nina, Henry and James chewed their food less in screen-based dining. James and Henry took longer pauses between two bites (inter-bite interval) in screen-based dining, hence their meal extended for longer in screen dining. Rahul and Nina took shorter pauses between two bites during screen-based dining. Rahul finished his meal in less time while eating in screen-based dining, whereas Nina took longer time to finish her meal in screen-based dining as she consumed more portions of food. Moreover, Rahul did not gaze at the food during screen-based dining as his complete attention was on the screen content; and Nina and Henry gazed at the food less when eating with screen. Finally, James gazed at the food more during screen-based dining because he had chicken, which he mentioned as his favorite food.

Finally, Timothy showed similar eating behavior in both contexts except that he did not gaze at the food while eating alone as seen in Table 5. It could also be because he ate the same food (soupy noodles) for all four meals. His attention in solo dining remained at his surroundings, whereas he gazed at the food during screen-based dining.

Most participants interacted very little with screens while eating and mainly enjoyed the already chosen media content, except for James and Violet who performed a lot of screen interactions while eating. Irrespective of whether the cutleries were used or not for eating, participants used the free hand for browsing. For instance, James used his right hand to browse the documents on his laptop and computer screen and ate his meal with his left hand.

F12: Screens did not prompt overeating. Participants described that screen content did not prompt them to overeat. As Henry mentioned, "*Yeah it [screen] is a distraction but it's not that distracting that I would overeat.*" Similarly, James mentioned that the screen content sometimes made him more attentive towards his food, "*If whatever I am watching is very boring then it would not prompt me to eat more but I would certainly concentrate more on eating.*"

F13: Hunger and the taste of the food defined the pace of the meal. Hunger and taste of the food influenced the eating topography of participants in a great deal. From the analysis of video recordings and diary entries, we found that when participants were hungry, they consumed their food more quickly, took bigger bites and had bigger portions of meal. For instance, Violet and Rahul took bigger bites, whereas Yulia and Belinda had bigger portions of food when

Table 5: Graphical representation of eating topography of participants for screen and solo dining contexts. The bar graphs are plotted by taking the average of two meals for each context.
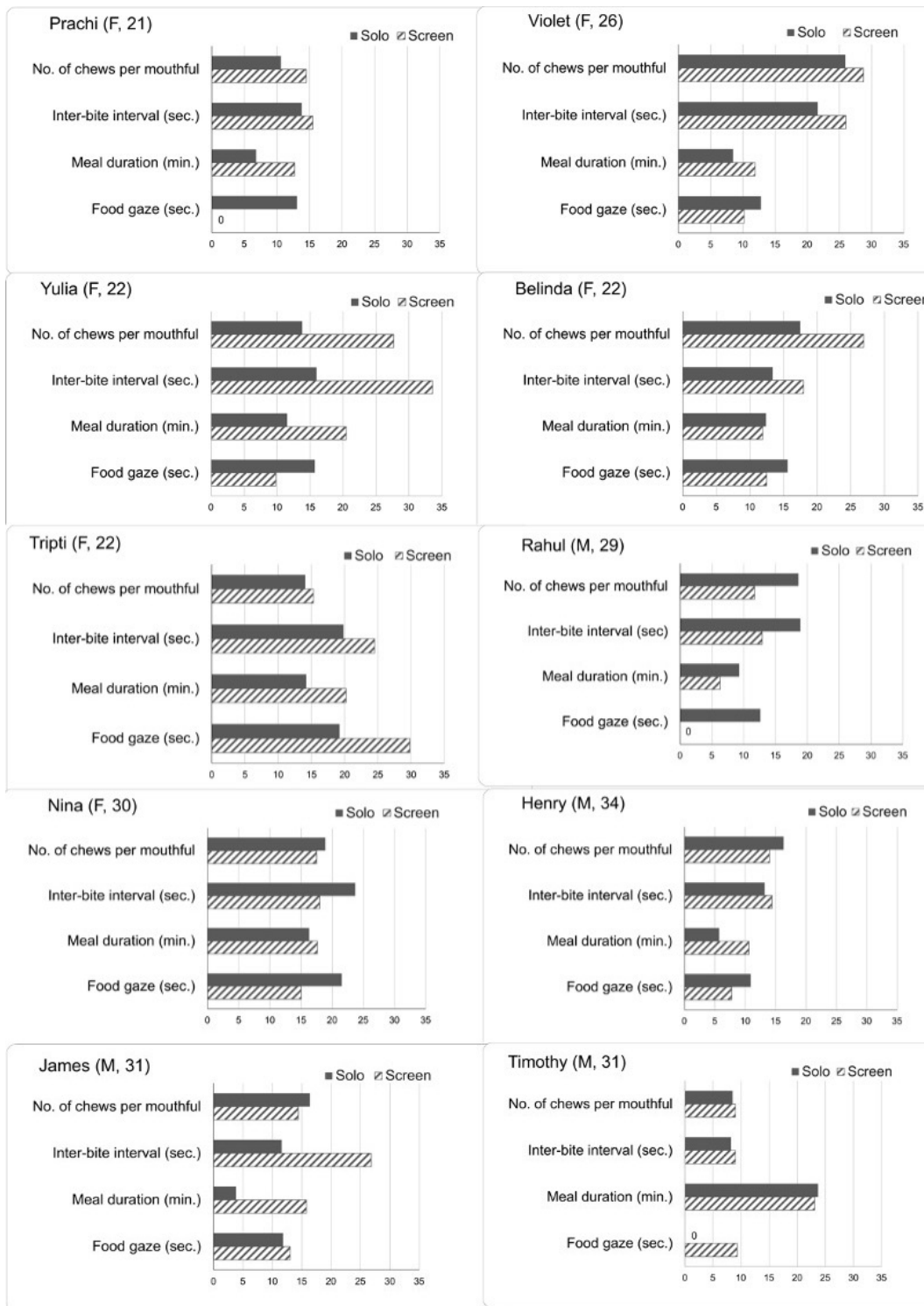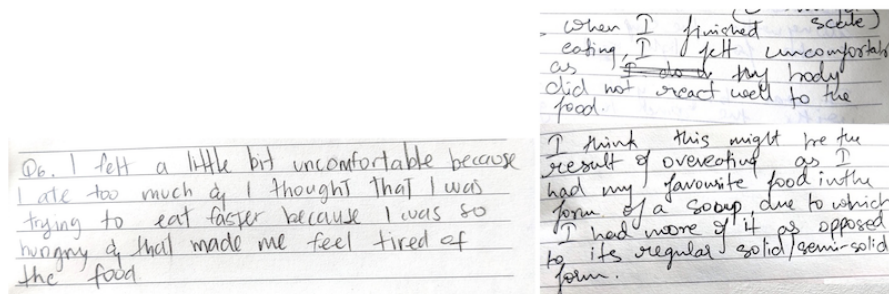
Figure 7: a) Violet commented on eating quickly because of hunger in one of the solo dining sessions. (b) Rahul mentioned about overeating his favorite food in one of the screen-based dining sessions.

they were extremely hungry. After the meal, participants mentioned about feeling uncomfortable due to fast eating (refer Figure 7a).

Interview data offered further insights into eating topography. Pace of the meal is also dependent on the taste of the food. Henry mentioned, "*If the food is good, I eat very fast. If it is something that I don't like, then the pace becomes slow.*" Similarly, Yulia mentioned, "*If I like the food I prepare, I eat faster or else I eat it slowly, the pace is dependent on the taste of food I eat.*" Figure 7b shows the diary log of Rahul, commenting on eating more of his favorite food that was described earlier in Figure 5.

4.4 Avoiding Distraction

The fourth theme describes whether and how participants manage giving full attention to the act of eating in both study contexts. All participants mentioned frequent use of their phone, laptop or television while eating but use of such devices did not feel as distraction and participants were able to attend to their food amidst these distractions.

F14: Screens added the much-needed background noise. Participants described that screen media mainly adds a background noise that helps participants to dismiss their thoughts and focus on their food. As Nina described, "*Screen is an escape if I don't want to sit alone with my thoughts, no matter how good my thoughts are. I want to get some mindless entertainment where I need to actively participate.*" Whereas for others, screen media offered companionship while eating. Tripti mentioned, "*I usually eat my lunch watching YouTube videos. I hate eating alone. Watching videos kind of feels like I'm with someone, even though I am watching nonsense.*" Participants also described their preference to eat with other types of background noise instead of eating alone. Belinda mentioned, "*I need some form of pleasant distraction to accompany my meal. When I go out for lunch, I prefer sitting in public at a place where there are some musicians playing songs. If I am inside, I am generally talking to people on my iPhone [while eating]*."

F15: Screen content was carefully chosen for mealtimes. Participants described being careful while selecting the screen content for mealtimes. They made sure that the screen content does not require their full attention and distract them fully from eating (refer Figure 8). Rahul added, "*Most of the time, I'd like to watch something that we've [refers to his partner, Nina] already watched because that way*
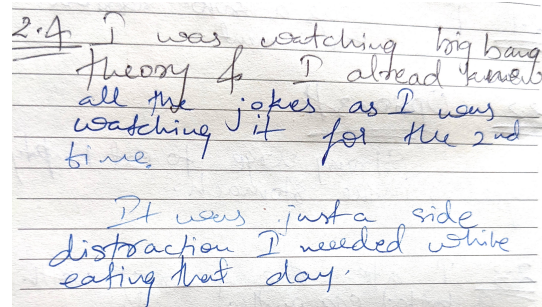

Figure 8: Rahul commented on the choice of media content for dining in his diary log.

we're very focused on eating, and it [screen] only serves as some background noise. We just laugh for a joke or two and it also allows us to have a conversation if needed". Henry and Violet also mentioned watching reruns of The Big Bang Theory series while dining together. Violet said, "*We've seen it at least three times. We're not even paying attention. Just, turn it on and that's it.*" During the study, participants watched a variety of content that included watching comedy shows and movies like *The Big Bang Theory, Imitation Game*, documentaries, news and browsing.

F16: Screens were missed in solo dining. Eating without a screen was uncommon for participants, and hence they were a little clueless on how they should occupy their mind during this time. Almost all participants repeatedly described eating without screens as boring in their diary logs (refer Figure 9). As a result, participants' gaze also went elsewhere besides the food. In one of the solo dining sessions, Rahul unknowingly started using his mobile phone after he heard a notification. The session was discarded for the data analysis. James vouched for eating alone mainly for its efficiency that allows him to quickly go back to his work. He mentioned, "*It's a very efficient meal, but it's not like I'm really enjoying it or savoring it.*"

F17: Solo dining involved other distractions. Solo dining involved other types of distractions, some were unexpected, and some were brought by the participants themselves. Participants tried to find some other form of distraction to keep their mind engaged while eating. For example, Nina constantly stared at the outside window, observing trees and birds while dining alone. She described it as

Figure 9: Participants found eating alone as boring: snapshots of the diary logs by Prachi, Violet and Belinda.

Figure 10: Different forms of distractions during solo dining: a) Nina enjoyed the bird singing; b) Violet mentioned an unexpected distraction of changing the thermostat.

a pleasant distraction in her diary log (refer Figure 10a). Violet mentioned an unexpected distraction of having to change the thermostat repeatedly due to the cold weather (refer Figure 10b). Yulia mentioned playing a tune in her head to keep herself occupied in her diary log. Planning the day ahead in their head was the most common activity that participants mentioned in the diary.

4.5 Being Non-judgmental

The final theme of non-judgement talks about thinking about food without any judgement.

F18: Taste of the food raised judgments. None of the participants mentioned that the media content has a role in their judgment of food. Firstly, the judgment of the food was driven by food characteristics such as taste. As Prachi expressed, "*If there's something that I don't like on my plate, I definitely would not consume it.*" On the other hand, Tripti described extending the meal to eating a dessert to repair the unpleasant experience of not-so-tasty food, "If the food is not good, I will need something else to give a happy ending to the meal like a piece of chocolate or something for me to feel satisfied."

F19: Visuals related to the food raised judgments. Visuals related to the food can also raise judgments. Factors like the food appearance and ambience of the place also play a crucial role to feel satisfied with the meal. Belinda mentioned in her diary logs how she associates visuals of Maggi noodles with its taste (Figure 11). Violet similarly mentioned, "*If the food was mediocre but the ambience was great [referring to dining out experience], I would still enjoy the experience.*"

F20: Home-made food triggered less judgments. Participants described being less judgmental about the food if they are involved in the cooking. Timothy expressed, "*If I'm the one preparing my food then I'm probably okay with whatever the outcome of the meal is. I'm not Gordon Ramsay or something, I don't criticize food as bad. If there are no major issues with the taste, I'm generally happy with my meal.*" Rahul described the reason behind feeling no judgments for home cooked food, as he said, "*When I cook, I know all the ingredients, and I also know how I have cooked it [meal] like how much oil and salt was used.*" For Henry, the social conversation afterwards was a sign of a satisfying meal. He added, "*When we discuss meals like who cooked it and how, what recipe was followed, that feels great.*"

F21: Health implications caused more judgements. The judgment also comes in terms of what is healthy and unhealthy for the body. Two participants were more critical about their food if they consumed unhealthy food. As Nina described, "*I am judgmental about food sometimes because I mostly want to eat what's good for my body. But when my partner orders something that I do not agree with, I try to avoid eating it or make sure to tell him that I'm not happy about it.*" However, not all participants were judgmental on their intake, for example Timothy, Henry and Rahul were happy with their eating irrespective of its nutritional quality or process. Rahul quoted, "*I try to be completely non-judgmental about my eating. Although I'm not there, 100 percent all the time, I know I'm there at least 90 percent of the time [laughs]. The rest of the 10 percent makes up for the occasional cravings that I have which I know are bad for me.*"

5 DISCUSSION

Our study findings revealed how screen-based media influenced the eating patterns of participants across the five principles of mindful eating. Table 6 separates the findings based on the influence of the screen-based media on eating behaviors.

Based on the study insights, below we present four design considerations that highlight the role of technology in facilitating mindful eating in the current realities of screen-based dining practices. We
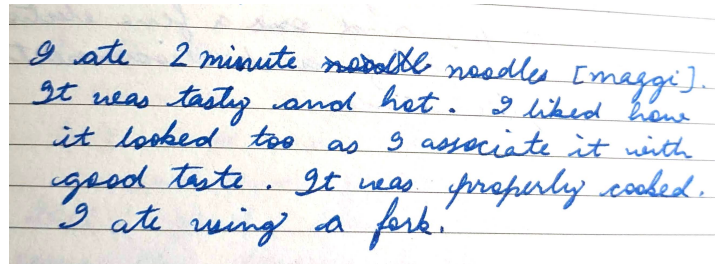
Figure 11: Belinda commented in her diary about how she associates visuals of the food to its taste.

Table 6: Summary of the findings based on the influence of the screen-based media on eating behaviors.

Mindful eating principles	Eating behaviors affected by screen media	Eating behaviors not affected by screen media
Being aware of bodily cues	F3: Screen based work led to dismissal of hunger cues	F1: Screen did not influence the body awareness F2: Attending to signals of hunger and satiety was important F4: Habits as well as body clock defined the meal timing F5: Availability of food prompted more eating
Savoring food	F6: Screen provided distraction to savor bland food and suppress cravings	F7: Tasty meals were savored more F8: Self-cooked meals felt more rewarding F9: Emotional attachment was found critical in savoring the food F10: Social eating enhances the food savoring
Eating topography	F11: Screen affected the eating topography F12: Screens did not prompt overeating	F13: Hunger and taste of the food defined the pace of the meal
Avoiding distraction	F14: Screens added the much-needed background noise F15: Screen content was carefully chosen for mealtimes F16: Screens were missed in solo dining	F17: Solo dining involved other distractions
Being non-judgmental		F18: Taste of the food raised judgments F19: Visuals related to the food raised judgments F20: Home-made food triggered less judgments F21: Health implications caused more judgments

understand the presence of screen-based technology during meal-time can be perceived as a contradiction to the concept of mindful eating. However, the rapid loss of social norms related to communal eating [87], the rise in lone-person households [95], and the increased portability and accessibility of screen-based media are making it difficult not to use screens while dining, which was also confirmed in our study. As found in our study, eating without screens was less enjoyable and was seen only to fuel the body (F16). Hence, discarding the screen altogether to support mindful eating is not a solution, rather we need careful technological interventions that can nudge people to adopt mindful eating practices in their everyday routine. We also acknowledge that not everything needs a technological fix and eating mindfully is certainly something that is very subjective and should be personally motivated. Eating mindfully however does not come naturally to everyone and technological interventions may help in avoiding the cold start. Once users see the benefits of eating mindfully in their everyday

routine, they may feel motivated to continue their practice without the need for any sustained technological nudge.

5.1 Designing for bodily awareness

In our study, we found that although participants had awareness of their bodily cues for hunger and satiety (F1), they mentioned having troubles in attending to their hunger cues when they were occupied with other tasks (F3). Dismissing the hunger cues pushed participants towards the extremities of hunger and they suffered with headaches and mood swings (F2). Participants mentioned that screens did not prompt overeating, rather the availability and portion of food trigger overeating (F5). This finding is in line with the earlier study [79], which also highlighted that accessibility of food contributes to increased food intake.

Users who do not realize bodily cues related to hunger and satiety or who ignore them even after realizing, may need a stronger push to change their habits. Designers could explore the potential

of uncomfortable interactions [11] to make users aware of their hunger and satiety cues. Benford and colleagues argue that uncomfortable interactions, when carefully applied, can stimulate powerful emotions as they are hard to ignore. Smart systems can be designed that can freeze the screen if the user eats too fast or takes bigger bites while dining with screens. Similarly, advertisements can be carefully placed in between the screen content, or the speed of the media content can be altered in real-time depending upon the user's eating topography, to give users some cues on paying more attention to their food. Also, uncomfortable interactions do not need to be driven by technology, instead rearranging the food can also contribute to improved awareness on eating practices. For example, Tai and colleagues [86] designed a playful yet uncomfortable dining experience, where the traditional way of eating a Caesar salad in a bowl with a fork was replaced by a skewer to visualize the hidden data about water consumption. Hence, food designers could also explore different food arrangements that can connect people with their bodily cues.

Designers could also explore the cross-modal design opportunities through uncomfortable interactions. For instance, existing literature on Soma aesthetic design discusses the usefulness of sound [49] and movements [54] to increase bodily awareness, which can be applied for screen-based dining. Learning from previous works like *GastroDigitalShirt* [9] and *Guardian of Snacks* [44], smart technologies can be designed that can play bodily signals such as growl or burp sounds to offer timely nudges to start and end the meal. Additionally, smart cutleries and dinnerware like *iScream*! [99] and *SWAN* [48] can also be designed to offer timely nudges on body awareness. For instance, as seen in *SWAN* [48], the utensils can make uncomfortable sounds or make different movements to grab the user's attention on their food and make them mindful of their consumption. Drawing on the alarm clock analogy, technologies could be built to offer better indications of the right time to eat and the right time to stop. Another concept of relevance here is of Hara hachi bu. "*Hara hachi bu*" is an ancient Japanese practice of eating until one is only 80% full. Designers can take inspiration from the Hara hachi bu lifestyle by increasing our awareness of our own body's cues. Going beyond self-reported scales and using sensors and technology to support better awareness and acknowledgement for one's bodily cues well in advance so that one can plan a course of actions, whether to eat or whether to stop eating. However, while designing uncomfortable interactions for screen-based dining, it is important to provide users control on the technology so that they can make their decisions regarding their mealtime practices.

Finally, bodily awareness on eating can also be facilitated through creating an enhanced version of eating, where the screen-based media and the food environments are augmented with the eating topography of dining partners. For example, Mitchell and colleagues [62] developed a novel augmented table designed to guide diners in keeping pace with others. In this system, actuators gradually raise the dish of a slower eating partner and lower the dish of a faster eater by a corresponding amount. These discrete movements act as nudges to guide the diners. Nabil and team [65] designed *ActuEating* that uses actuating dynamic material to develop a dining table which changes shape and color in response to diners' actions. Mehta and colleagues [60] created an on-body robotic arm-based system for dining in "*Arm-A-Dine*" that sublets

the control on eating action to dining partner. For example, if we eat with our own arm, decisions about quantity and eating speed are in our hands and so is the choice to overeat. However, when we no longer control these actions autonomously and we allow the robotic technology to playfully subvert these actions, we could potentially regulate both quantity and eating speed. Building on these research efforts, there are definite merits in exploring feedback on eating topography through social means. Similarly, gustatory displays can be designed, where the flavor of the next bite is altered based on the individual's eating topography. Here, the change in the taste may divert the individual's attention from screen to food. More research is required to understand how dining partners will use such feedback, whether it will nudge them to help each other in eating mindfully.

5.2 Designing for Savoring

In our study, we found that participants savored the tasty meals most (F7). They used screen media to savor bland food as well as to suppress their cravings for certain foods (F6). Participants savored their food more when they were involved in the cooking (F8), and when they had some emotional or cultural connection with it (F9). Participants expressed the enjoyment and satisfaction that arises out of planning and preparing food. Besides, social dining and conversations around food also increase their appreciation for food (F10). As such, these findings suggest that it is important to think of dining as a wholesome experience that not only comprises eating but also other activities like shopping the ingredients, cooking, ambience of eating and dining companionship.

Our findings support the existing literature where it is observed that the pleasure experienced in anticipation of a consumption event exceeds that experienced during actual consumption, often referred to as 'anticipatory savoring' [4]. Drawing on these insights, we suggest designing technologies for anticipatory savoring that can facilitate the experiences of sourcing ingredients and meal preparation. For instance, services like *HelloFresh* [111] create a surprise element as the customer receives the ingredients to try different recipes for their meals. Moreover, technologies should also be designed to make cooking a social activity, where the user can invite their friends and family to accompany them in the cooking. More attempts should be made to pass on the intergenerational recipes to increase savoring through emotional connection, such as the work done by Awori and colleagues [7] who explored the use of video mediated technologies to support transfer of indigenous recipes. Since meal preparation is a messy activity, technologies need to be specifically designed that can cater the needs of users appropriately through gestures or voice commands. For example, 360 degrees cameras can potentially support the conversations and interactions for remote cooking sessions (ibid).

To increase fun in the everyday mundane food preparation, designers can also design novel 'experimental experiences. For instance, going against the traditional stance of designing technologies for perfection in cooking, technologies could be designed that allow users to make errors to increase engagement in meal preparation. For example, for those who love to cook, the act of cooking can be rewarding and pleasant in itself, without knowing what the result will be. The pleasant experience holds true as long as there is

enough challenge and curiosity. Moreover, food properties such as viscosity, chewability, or stickiness can also be altered to heighten the experience of mouthfeel for anticipated savoring. Projects like *LoLLio* [64] is an example of how interactive technology can be designed to alter the taste dynamically. Similarly, designers can also explore the shape [97, 106], texture [29], visual representation [47] and sound [50] of the food and its utensils to create more opportunities for savoring. Technologies like 3D food printing [33] can be utilized to allow the users to experiment with the look, texture and taste and to recreate the intergenerational recipes.

Finally, we often don't eat all of the variety of flavors —salty, sweet, bitter, savory, and umami in a single meal, resulting in feeling like we are "missing something," and ultimately, food cravings can result. For example, a couple of study participants frequently wrote in the diary craving for sweets once they finished their meal. By rearranging how a meal is consumed and separating out essential flavors or adding small amounts of all the flavors of food, a practice common in Asian culture could lead to a more satisfying meal and less craving afterward. As Gayler and colleagues [33] wrote in their review article on HFI, food is a rich design material as it can be experienced both from outside the body (smell, sound, vision and touch), in the mouth (taste, smell, texture and temperature), and inside the body (digestion and metabolization). Drawing on these, specific mindful eating experiences can be designed targeting intervention outside the body, inside the mouth and inside the body. For example, a cross-modal systems like *GustaCine* [43] targets intervention outside the body and inside the mouth, where flavors of the popcorn are altered dynamically based on the movie emotions to allow savoring of cinematic moments and to prevent mindless eating. Similarly, Arnold and colleagues [5] designed a gustatory interface, "*You Better Eat to Survive*", to control actions in a mobile Virtual Reality game. Although this game is not directly targeted at mindful eating, it does involve intervention inside the mouth. Since the game is played while wearing a VR headset, players no longer had sight of the food. Rather than approaching it as a problem, the game repurposes the eating actions as a game interface to facilitate an engaging cross-modal game experience. Systems like "*You Better Eat to Survive*", suggests that by connecting game actions with the chewing activity, there is a potential to influence oral processing of food and nudge individuals towards eating slowly and taking time between bites, and thus savoring their food.

5.3 Reframing Distraction as a Companion

Our study revealed that screens added the much-needed background noise for participants to keep their minds occupied during mealtime (F14). Screen content was carefully chosen for mealtimes (F15) and participants never watched anything that required their full attention. Rather, participants watched the same media content as movies or tv serials again. Screens were missed in solo dining (F16). Eating with screens was a norm for participants as they wanted some form of companionship during mealtime. Participants also mentioned that screens did not prompt overeating (F12) and they were able to enjoy the food whilst watching the media. On the other hand, solo dining also involved other types of distractions (F17) both unexpected and deliberate. As eating alone was uninteresting, participants tried to deliberately keep themselves

occupied with some thoughts. Our study findings are consistent with prior research on solo dining that highlights how eating alone is less motivating and feels more as a necessity [35, 81].

Our study highlighted that the real-world is full of distractions, hence avoiding distractions to practice mindful eating in everyday routine does not seem feasible. It is time to acknowledge the pervasive presence of screen media in our lives [72] and reconsider their presence as a companion rather than as a distraction for eating. Works by Ferdous and team [23, 24] suggest how repurposing everyday technologies like phones and tablets around mealtimes can act as a medium to facilitate shared activities during mealtimes and can lead to a positive experience of eating together. Earlier study by Chitakunye and Maclaran [16] also reports on the companionship that a typical distraction technology like mobile phone affords. Their study reports on how smartphones enable diners to physically see a person through their phone and feel as though their friends and family are eating with them. Instant messaging on phones enables them to share their feelings towards their teachers and parents, a practice that they found to be humorous.

Using objects as partners or companions is not new in the field of HCI. Rozendaal and colleagues [78] discussed the usefulness of smart everyday things as collaborative partners that could motivate individuals to participate in activities that they otherwise are less motivated to do. The authors suggest that everyday things can have an artificial agency, which is delegated to them by someone or something (such as designer) in order to help users in following a certain behavior. We already see examples of such artificial commensal companions in prior works such as *Arm-a-Dine* [60], *FoodChattAR* [103], *FoBo* [45], and *Guardian of the Snack* [44]. For example, *Guardian of the Snacks* [44], is a tangible turntable based multimodal system that encourages mindful snacking by offering a playful companionship to snacking. The system has a physical pet-like appearance that gives users the feeling of having company while the system also offers audio feedback in terms of the chewing and burping sounds that mimics bodily signals that would indicate the time to eat and time to stop; and the movements of the turntable to conceal and reveal the snack add discipline to one's snacking routine.

Similarly, for screen-based dining, such agency could be defined in terms of how to use the screen content to promote mindful eating. For instance, designers could consider adding a 'mindful eating' mode on the popular online streaming applications like *Netflix, Apple TV* and *Amazon Prime*. Users can create a list of media content that is fine to watch during mealtime. The mindful eating mode could also provide other functionalities like run time (that stops the video after a certain time), pause time (that pauses the screen content after every few minutes) or slow down time (that slows down the content rendering speed). These design features can disrupt the content consumption mentality of users and get their attention towards their food and eating practice.

5.4 Nurturing a non-judgmental attitude to eating

Being non-judgmental is the hardest part of following the mindful eating practice. Our brains are hardwired to judge the actions and events based on their merits. In our study, we found that screens did

not trigger any judgments for the food, rather other factors like taste of the food (F18), visuals related to the food and surroundings (F19), involvement in food preparation (F20), and health implications (F21) raised judgments. These findings are consistent with existing literature on eating practices [14, 37, 101].

Being non-judgmental is not about stopping judgments from ever arising; Instead, it is about changing the relationship to our judgements (Dutton, 2008). Dutton (Dutton, 2008) argues that *"Thoughts are not inherently harmful or destructive. Rather, it is our reaction to these thoughts that can become problematic".* Once we're able to trace back our emotions around food and acknowledge the dynamics at play, we are better equipped with managing our notions that some foods are 'good' and others are 'bad'. Food is just food. In observing the mind in this way, we can free ourselves from emotions that fuel our habits. However, the recent trends of self-tracking, food journaling and the diet fads that categorize food based on their components like sugar, carbohydrate and protein may trigger judgmental thoughts towards food. While monitoring the food intake is useful for certain populations like athletes and cinema stars, keeping a count of calorie intake for general users may further distance them from their food. Food journalism apps for mindful eating should therefore encourage users to reflect on how they felt after eating the food, instead of asking them to infer the nutritional content of the food.

Non-judgmental attitudes to food can also be encouraged by cultivating stronger relationships with food [86] Our study participants mentioned how food becomes more valuable if there is some emotional connection with it like cultural significance (F9) or self-involvement (F20). Learning from the work of Grimes and Harper [34], we suggest designing celebratory technologies to change our attitude towards food from judgmental to celebrations and appreciation. Celebratory technology emphasizes aesthetics, creativity, endowment, relaxation, and nostalgia to design positive interactions around mundane eating activities. For instance, we can create emotional connection with food through food provenance, i.e., by highlighting the roots of the food, such as where the food was grown, how it was produced, and how it was transported and delivered. Previous works [86] suggest that by creating awareness about the distribution channels and the pollution contributed to developing certain food items help in bringing appreciation and gratitude for food. Technologies can also be designed to connect food consumers to food producers in real-time. For example, having a short conversation with the farmers about the food being eaten may enable mindfulness. Understanding the reasoning behind food choices could also prompt individuals to evaluate if their dietary habits are best for themselves and for others.

6 LIMITATIONS

Our study has certain limitations. The study was conducted with a small sample group from a single geographic region. Longitudinal studies with participants from different age-groups and with diverse backgrounds would unveil further insights to complement findings from this study. Nevertheless, this is the first field study that offers rich insights of the mindful eating practices of people in natural settings, as previous studies on understanding mindful eating practices have been limited to lab settings. Finally, we would

also like to reiterate the importance of studying human activities in natural settings [77]; and we highlight the need to consider the individual differences in consuming screen media while eating, as these differences shape the user's reaction to digital technologies.

7 CONCLUSION

In this paper, we presented the first conceptual understanding of whether and how screen-based media influences our eating practices. By employing the lens of mindful eating practices, we investigated the differences in eating practices of people with and without screen. Our study revealed that screens had some influence on bodily awareness related to hunger, helped in savoring the bland food, altered eating patterns like food gaze and chewing rate, and was treated as a pleasant companion while eating. On the other hand, screen media did not trigger judgments for the food. We also highlight other non-screen related factors like emotional connection, taste and visuals of the food, involvement in food preparation and health implications that influenced participants' eating behaviors. Drawing on these insights, we presented four design considerations that highlight opportunities on how to bridge the barriers between the ideologies of mindful eating and the realities of screen-based dining cultures through innovative technological designs, a forte of the HCI field. This understanding will be of importance for designers and practitioners aiming to promote mindful eating practices in everyday routine. Finally, helping people to eat mindfully can nurture a strong and healthy connection with food. As Sodus mentioned, "*diet fads will come and go, but the wisdom of eating each bite of food while awake, aware, and alive can nourish us for a lifetime*" [81:52].

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